Mission Coordination and Co-Localization for Planetary Rover Teams, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Cooperative robots can explore the surface of planets with higher efficiency and lower mission risk, perform novel and precise resource and science surveys, and gather and share resources and information with other assets to bring planetary exploration. In order to work together more efficiently and effectively, robots must understand their location relative to their peers, which is challenged in planetary exploration by the fact that these environments lack global positioning systems to enable a robot to understand its absolute location in space.

State-of-the-art simultaneous localization and mapping (SLAM) techniques can accurately localize without explicit pose sensing, but also require high-end range sensors, high-fidelity vision, and powerful onboard computing. Adding these computing and sensor demands on paired and multi-agent systems begins to defeat the purpose - paired exploration is advantageous precisely because it can be used to field more minimalist robots that can devote energy to rapid traverse, multi-angle inspections, or specific scientific instruments.

The proposed work will develop two key techniques to improve the foundation for cooperative planetary robotic missions:

1. Novel methods for co-localizing multiple robots using relative observations

2. Methods for planning multi-robot paths that reduce localization uncertainty and improve positioning accuracy of robot teams.

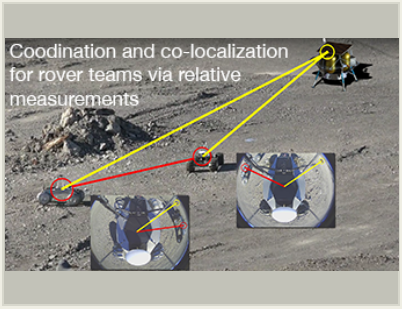
This research will enable more accurate localization of multiple planetary exploration robots without requiring high-fidelity sensing and powerful compute.

Anticipated Benefits

Rover co-localization could expand science surface missions by enabling multi-rover missions to explore more efficiently and to localize themselves with more precision. We envision this technology in multi-rover bulk surveys of volatile concentrations, where many small rovers collect data to build a map of distribution. Other distributed science applications can benefit from accurately localized small rovers. The developed techniques also scale to combined UAV and surface rover missions.

Robots with better collaborative situational awareness could provide a greater level of human safety, more efficient work planning, or better protection for capital equipment.

For example, in agriculture, the ability to share localization data within robot teams could improve the ability of robots to perform numerous tasks, from monitoring to seeding to harvesting.



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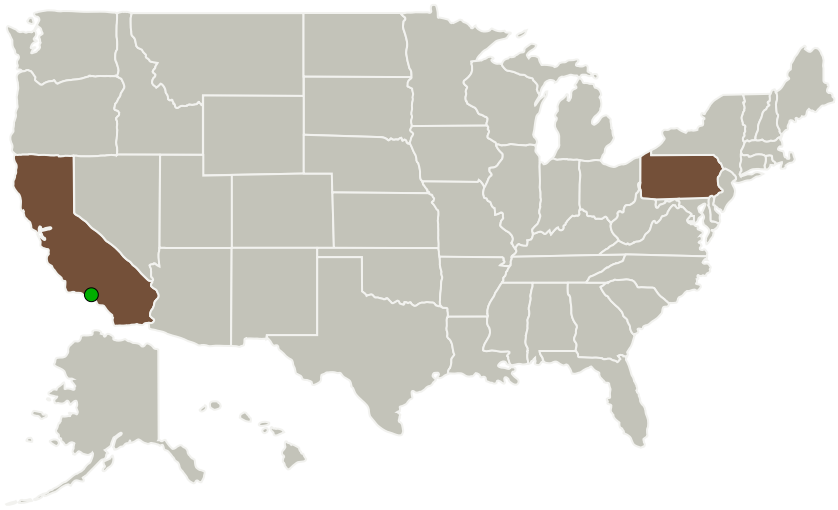
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Astrobotic Technology, Inc.	Lead Organization	Industry	Pittsburgh, Pennsylvania
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

July 2018: Project Start

August 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141175)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Astrobotic Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

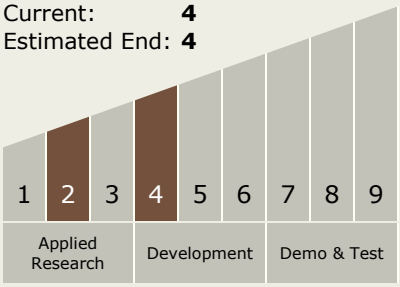
Carlos Torrez

Principal Investigator:

William Whittaker

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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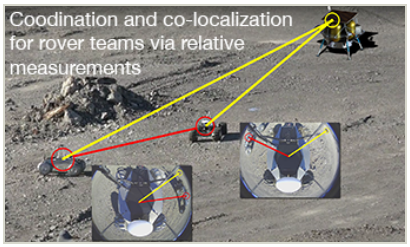
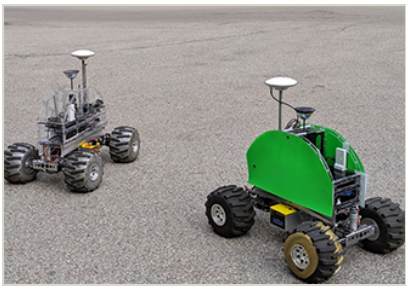
Images



Briefing Chart Image
Mission Coordination and Co-Localization for Planetary Rover Teams, Phase I
(https://techport.nasa.gov/image/134139)



Final Summary Chart Image
Mission Coordination and Co-Localization for Planetary Rover Teams, Phase I
(https://techport.nasa.gov/image/133797)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.6 Collaborative Mobility

Target Destinations

The Moon, Mars, Others Inside the Solar System